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Exponential stability and interval stability of a class of stochastic hybrid systems driven by both Brownian motion and Poisson jumps

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Abstract: A class of stochastic singular hybrid systems driven by both Brownian motion and Poisson jumps are studied. This paper is devoted to discussing the exponential stability and interval stability of such stochastic singular hybrid systems. The concept of interval admissibility is proposed. Sufficient conditions are given for exponential mean square admissibility and interval admissibility by using Itô's formula, $\mathcal{H}$-representation and spectrum technique. Finally, two simulation cases are presented to demonstrate the theoretical results.

Keywords: Brownian motion, Poisson random measure, stochastic singular hybrid systems, exponential stability, interval stability, Markov chain.

1 Introduction

Comparing normal systems, researches on singular systems [1] are more complex, which need to ensure stability, regularity and non-impulsiveness (in the continuous case) or causality (in the discrete systems) simultaneously. However, singular systems provide more convenient and natural representations for the description of many fields such as economics, traffic systems, electrical systems, demography, robotics and so on. Currently, singular systems have been studied comprehensively. The past decade witnessed the successful employment of singular systems, many important notions and results have been proposed, for example, stability analysis [2–6], H_∞ control and filtering [7–9], controllability, observability, and duality [10]. On the other hand, many physical systems may face abrupt changes in the structures and parameters due to component random failures or repairs, or sudden environmental disturbances. It is well-known that these abrupt changes can be described by Markov chains [11]. The continuous-time singular systems driven by Markov chains as

$$Edx(t) = A(r_t)x(t)dt. \tag{1}$$

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